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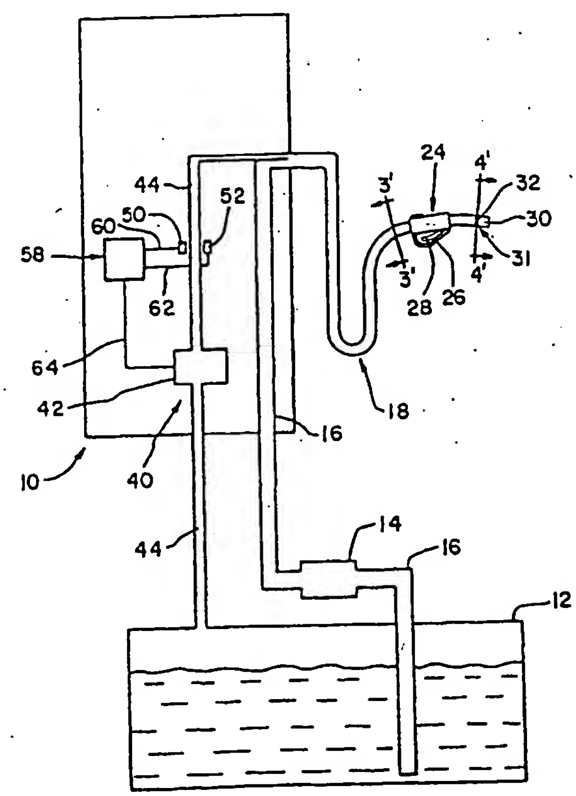
(54) Title: ORVR DETECTION VIA DENSITY DETECTOR

(57) Abstract

A vapor recovery system (10) with density detector (58) for identifying the vapor composition of recovered vapor. The system (10) controls the operational rate of vapor collection when the recovered vapor is identified as substantially non-hydrocarbon. Density detection is achieved through correlating the speed by which sonic or acoustic energy traverses through the recovered vapor. The vapor composition is identified by comparing measured density of the vapor collected to known vapor densities.



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ORVR DETECTION VIA DENSITY DETECTOR

BACKGROUND OF THE INVENTION

1. Field of the invention.

The present invention relates to an ORVR vehicle detection and control system for a vapor recovery system, and in particular, a system for detecting ORVR vehicles by detecting the density of vapor recovered and controlling a vapor recovery system when an ORVR vehicle is detected.

2. Description of the related art.

The evaporative properties of liquid fuel creates a vapor condition within vehicle fuel tanks, in which a volume of volatilized fuel vapor overlies the volume of liquid fuel. During the course of refueling the vehicle, the gasoline flowing into the fuel tank will displace the existing fuel vapor and cause such environmentally hazardous vapors to be forced out of the vehicle fuel filler tube and into the ambient environment unless precautionary measures are followed to collect and dispose of the discharged vapors. Rising public awareness of the adverse environmental and health consequences of fuel vapor pollutants has prompted governmental authorities to require that fuel dispensing systems be designed to reduce or eliminate the release of fuel vapors into the atmosphere by collecting the fuel vapors for storage and possible recycling. These concerns have led to

the development of various systems designed to collect and return the fuel vapor emissions to a vapor storage tank which typically corresponds to the on-site underground facility located at the service station where the fuel supply is maintained. The recovery vapors may be further transported to a processing site where the vapors are returned to liquid form in a recycling operation or otherwise disposed by appropriate means.

One class of conventional vapor recovery systems utilizes a vacuum pump to assist in the collection of fuel vapors and their subsequent transport to an underground fuel storage tank. The vacuum pump draws fuel vapors into an intake line that conveys the collected vapors back to the vapor storage tank. The negative pressure generated by the vacuum pump is normally sufficient to capture the vapor emissions, thereby obviating the need for any sealing element, such as a bellows member, that is otherwise used to surround the nozzle and seal the vapor recovery passage to the filler neck of the tank. The inlet port of the vapor intake line need only be disposed in close proximity to the filler neck of the fuel tank where the vapors emanate.

It is important in all such vacuum-assist vapor recovery systems that the volume of gaseous mixtures drawn in through the vapor recovery inlet closely proximate the volume of vapor being displaced by the gasoline flowing into the fuel tank.

If the volume of the vapor being collected is less than being displaced, the non-recovered portion will dissipate into the environment. Conversely, if the volume of fuel vapor being collected is greater than the volume being discharged from the tank, the excess volume will consist of atmospheric air that is recovered along with the fuel vapors. Both conditions are to be avoided. Several configurations have been proposed that focus upon making calculated adjustments to the flow rate generated by the vapor pump based upon measurements produced by sensing apparatus that monitor the fueling and vapor recovery operations.

Another method of preventing volatile fuel vapors from emanating from the filler tube of the vehicle tank while refilling is an Onboard-vehicle Recovery Vapor Recovery system (ORVR). An ORVR system captures any fuel vapors present in a vehicle's fuel tank whereby preventing the fuel vapors from escaping into the environment. During refueling, a liquid or mechanical seal at the nozzle is created, thereby the vapors are trapped in the fuel tank. The ORVR collected vapors are then directed to the vehicle's engine for combustion.

One problem with traditional vapor recovery systems is that they do not adjust operation to accommodate vehicles with ORVR. Failing to differentiate between vehicles with ORVR and vehicles without ORVR may result in an increase of fugitive emissions from the underground storage tank. For example,

when a dispenser's vapor recovery system is used in conjunction with a vehicle with ORVR system, the respective systems work against each other. Conversely, an ORVR system forces fuel vapors from the fuel tank's filler tube into an onboard collector whereby preventing fuel vapors from emanating from the filler tube and into the environment. The result of the opposition of the respective system may be a shortened life of the dispenser vapor recovery system and forcing fuel vapor from the underground storage tanks. Another way, the problem with operating a dispenser's vapor recovery system in conjunction with a vehicle's ORVR system is that atmospheric air will be collected in the fuel dispenser's underground vapor collection and storage tank. An ORVR system attempts to remove any fuel vapors from a vehicle's fuel tank. Therefore, the vapor collected by a dispenser's vapor recovery system will be atmospheric air which is drawn into the vehicle's filler tube by the dispenser's vapor recovery system. The added volume of atmospheric air in the fuel dispenser's vapor collection and storage tank results in a larger volume of total recovered vapor to be properly disposed or processed. Consequently, disposing the entire volume of recovered vapor results in an increase in cost of vapor recovery.

SUMMARY OF THE INVENTION

According to the present invention, a density detector is used to identify the vapor composition of vapor recovered by a fuel dispenser's vapor recovery system. The vapor recovery system contains a vapor collection means for recovering vapors from a vehicle's fuel tank. The system controls the operational rate of a vapor collection means when the recovered vapor is identified as non-hydrocarbon or having a reduced hydrocarbon composition.

The invention, in one form thereof, is a vapor recovery system for recovering fuel tank vapor from a vehicle when the fuel tank is being refueled. The vapor recovery system includes a vapor collection means for variably collecting fuel filler tube vapors from the fuel tank. A density sensor means generates a density signal representative of a density of the collected fuel filler tube vapor stream. A controller means is operatively connected to the vapor collection means and said density signal for controlling said vapor collection means. The controller means utilizes said density signal and generates a control signal transmitted to said vapor collection means for varying the operational rate of the vapor collection means. In one particular embodiment, the density sensor means includes an acoustic transmitter and an acoustic receiver.

The invention, in another form thereof, is a method for detecting vehicles with On-board Vehicle Recovery Vapor Recovery systems (ORVR). The method includes sampling vapor present in a fuel filler tube and measuring the density of the sampled vapor. The presence of hydrocarbon within the sampled vapor is determined as a function of the vapor's density. In the one particular embodiment, the step of measuring of the density of the sampled vapor includes transmitting a pulse of acoustic energy through the sampled vapor and detecting the pulse of acoustic energy sent through the sample vapor. The density of the vapor is determined as a function of the speed by which the pulse of acoustic energy traverses the vapor.

The invention, in yet another form thereof, is a method for operating a vapor recovery system which includes the steps of supplying a vapor recovery intake line to the fuel filler tube and applying negative pressure to the vapor recovery intake line to recover vapor. The density of the recovered vapor is measured and the composition of the recovered vapor is determined as a function of measured vapor density. The application of negative pressure to the vapor intake line is decreased when it is determined that the vapor composition is non-hydrocarbon based upon such a predetermined density level. In one particular embodiment, the density of recovered vapor is measured by transmitting a pulse of acoustic energy through the recovered vapor and detecting the pulse of acoustic energy

sent through the recovered vapor. The density of the recovered vapor is determined as a function of the speed by which the pulse of acoustic energy traverses through the recovered vapor.

The invention in another form thereof, is a vapor recovery system for recovering vapors from a tank of a vehicle while refueling. The vapor recovery system includes a vapor recovery intake line and a vapor recovery pump for recovering the vapors through a vapor recovery inlet line. A density sensor means generates a density signal representative of a density of the vapor. The density sensor means includes an acoustic transmitter and an acoustic receiver. A controller means is operatively connected to the vapor recovery pump and receives the generated density signal. The controller means determines fuel tank vapor composition and thereby, generates a control signal representative of the vapor composition. The control signal is used for varying the operational rate of the vapor recovery pump as a function of vapor composition or density.

An advantage of the present invention is the ability for a fuel dispenser to identify vehicles with ORVR. The present invention identifies the composition of vapor recovered by a fuel dispenser's vapor recovery system. The absence of hydrocarbon in the collected fuel vapor is one indication of an ORVR vehicle.

Another advantage of the present invention is the ability to decrease or deactivate a fuel dispenser's vapor recovery system when an ORVR vehicle is detected. There are several reasons why it is advantageous to decrease or deactivate a fuel dispenser's vapor recovery system while refueling a ORVR vehicle.

One advantage to deactivating a fuel dispenser's vapor recovery system when an ORVR vehicle is detected is to prevent possible damage to, and reduce wear on, the respective vapor recovery systems and fuel storage container. If a fuel dispenser's vapor recovery system is operating while a vehicle's ORVR system, the respective systems will operate in opposition to one another. For example, excessive wear may result on the fuel dispenser's vapor recovery pump. Therefore, it is advantageous to not operate both a fuel dispenser's vapor recovery system and ORVR concurrently. The present invention prevents potential damage to a fuel dispenser's vapor recovery system by reducing or deactivating a fuel dispenser's vapor recovery system when an ORVR vehicle is detected.

Another advantage of detecting a vehicle with ORVR is a decrease in the amount of atmospheric air which may be collected by a fuel dispenser's vapor recovery system. An ORVR system removes fuel vapor present in the vehicle's fuel tank. When refueling a vehicle having an ORVR system, there

is no fuel vapor present in the fuel tank filler tube. Consequently, the fuel dispenser's vapor recovery system will collect or recover atmospheric air instead. The atmospheric air is then collected in the fuel dispenser's vapor collection and storage tank. The present invention prevents the accumulation of atmospheric air in a fuel dispenser's vapor collection tank by decreasing or deactivating the dispenser's vapor recovery pump when an ORVR vehicle is identified and/or non-hydrocarbon vapor is detected.

BRIEF DESCRIPTION OF THE DRAWINGS

The above-mentioned and other features and advantages of this invention, and the manner of attaining them, will become more apparent and the invention will be better understood by reference to the following description of an embodiment of the invention taken in conjunction with the accompanying drawings, wherein:

Fig. 1 is a sectional view of a fuel dispenser incorporating the present invention;

Fig. 2 is a cross-sectional view of a density detector of one particular embodiment of the present invention;

Fig. 3 is a cross-sectional view, along line 3'-3'(Fig. 1), of a dispenser hose; and

Fig. 4 is a cross-sectional view, along line 4'-4'(Fig. 1), of a dispenser nozzle around vapor recovery inlet port.

Corresponding reference characters indicate corresponding parts throughout the several views. The exemplification set out herein illustrates one preferred embodiment of the invention, in one form, and such exemplification is not to be construed as limiting the scope of the invention in any manner.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to the drawings and particularly to Fig. 1, there is shown a fuel dispenser 10 which incorporates the present invention. Fuel dispenser 10 includes a dispenser tank 12. Fuel pump 14, when activated, pumps fuel from fuel tank 12 through fuel conduit 16 to hose 18. Hose 18 is connected to nozzle 24. Nozzle 24 contains handle 26 and lever 28. Nozzle 24 also contains an outlet 30, from where fuel is dispensed. A plurality of apertures are disposed annularly around nozzle 24 near outlet 30 and form inlet port 31.

Referring to Fig. 3, hose 18 contains two discrete and separate channels. An inner channel or fuel channel 20 is surrounded by outer channel or vapor intake line 22. Inner wall 23 prevents fuel and vapor from coming into contact with one another. Outer wall 25 prevents vapor from being exchanged between intake line 22 and the environment.

Referring to Fig. 4, nozzle 24 also contains fuel channel 20 surrounded by vapor intake line 22 as defined by inner wall

23 and outer wall 25. Fuel is dispensed from fuel channel 20 to a vehicle's fuel tank through outlet 30 (Fig. 1). Inlet port 31 is comprised of a plurality of apertures 32 which are disposed annularly in outer wall 25 near outlet 30. The plurality of apertures 32 permit vapor to pass between the outside environment and vapor recovery intake line 22.

Referring back to Fig. 1, vapor collection means 40 includes vapor recovery pump 42 and vapor recovery intake line 22. Vapor recovery intake line 22 is connected to vapor recovery conduit 44, which in turn is connected through pump 42 to dispenser tank 12.

During the operation of the vapor collection means 40, vapor recovery pump 42 vacuums vapors from the environment directly outside of inlet port 31. When nozzle 24 is disposed within a fuel filler tube of a vehicle, vapor collection means 40 vacuums vapors present in the fuel filler tube. The vapors are evacuated into vapor recovery intake line 22 through a plurality of apertures 32 under negative pressure generated by vapor recovery pump 42. The collected or recovered vapors proceed through vapor recovery intake line 22 into vapor recovery conduit 44, passing through pump 42, and on to dispenser tank 12.

Referring now to Fig. 2, the present invention includes a density detection means which comprises a sonic transmitter 50 and sonic receiver 52. During the operation of vapor recovery

system 40, sonic transmitter 50 transmits pulses of acoustic energy through vapor recovery conduit 44 towards sonic receiver 52 while vapor recovery pump 42 is operating. The density of the recovered vapor passes through vapor recovery conduit 44 is measured as a function of the time it takes for a pulse of acoustic energy to traverse vapor recovery conduit 44.

It takes longer for a pulse of acoustic energy to travel through a vapor of low density as compared with a vapor of high density. Therefore, as the density of the vapor within vapor recovery conduit 44 decreases, the longer it takes for a pulse of acoustic energy to traverse vapor recovery conduit 44. Conversely, vapor recovered with a higher density results in a shorter time for acoustic energy to traverse vapor recovery conduit 44.

The vapor constituents present in the recovered vapor can be identified by correlating the detected density of the recovered vapor to various gasses with known densities. Therefore, vapor constituents can be identified from detected vapor density. A high measured vapor density indicates the presence of hydrocarbons whereas a low vapor density indicates the presence of atmospheric air.

ORVR vehicles can be identified by the vapor constituents present in the recovered vapor. Vehicles with ORVR do not emanate substantial amounts of fuel vapors (i.e.,

hydrocarbons) from the vehicle's fuel filler tube during refueling. Consequently, during the operation of vapor collection means 40, substantially no hydrocarbon vapor will be present in vapor recovery conduit 44. Density detector means 48, along with controller means 58 will identify the absence of hydrocarbon as an indication that the vehicle being refueled is an ORVR vehicle.

Sonic transmitter 50 and sonic receiver 52 are operatively associated with controller means 58 by sonic transmitter signal line 60 and sonic receiver signal line 62. Controller means 58 controls the generation of acoustic pulses which sonic transmitter 50 generates and directs through vapor recovery conduit 44.

During operation, controller means 58 initiates a sonic transmitter signal along line 60. Sonic transmitter 50, upon receiving a sonic transmit signal, emits a pulse of acoustic energy through vapor recovery conduit 44 towards sonic receiver 52. Sonic receiver 52 detects the pulse of acoustic energy and transmits a sonic receiver signal through line 62 to controller means 58. Controller means 58 measures the time it takes for the pulse of acoustic energy to travel between sonic transmitter 50 and sonic receiver 52, e.g. pulse of acoustic energy traversing vapor recovery conduit 44.

Controller means 58 first determines the density of vapor within vapor recovery conduit 44 by correlating the speed by

which the acoustic energy traverses vapor conduit 44 to a density value and generates a density signal representative of that density value. The density signal is generated from SUAG.

Control means 58 then determines the vapor constituents by correlating the measured density to known vapor densities and converts the density signal to a control signal to be sent down line 64. The presence of hydrocarbon within the recovered vapor is determined as a function of measured vapor density. For example, control means 58 may identify a vapor not containing hydrocarbon, e.g., atmospheric air, when the determined density is low and a vapor consisting of hydrocarbon when the determined density is high.

A control signal is sent down from control line 64 from controller means 58 to vapor recovery pump 42. Controller means 58 controls the rate of operation (rate of speed or created vacuum) of vapor recovery pump 42. When control means 58 identifies the vapor within vapor recovery conduit 44 as a non-hydrocarbon, control means 58 relays a control signal down line 64 to pump vapor recovery pump 42 to decrease the rate of operation of vapor recovery pump 42 or its level of vacuum produced.

Density sensor means comprises acoustic or sonic transmitter 50, sonic receiver 52, and controller means 58 to generate a density signal representative of a density of the

vapor within vapor conduit 44. While the density detection means disclosed here is an acoustic transmitter and receiver, other means of measuring vapor density within line 44 may be employed. Sonic transmitter 50 and receiver 52 may be disposed within vapor recovery pump 42.

During the operation of the present invention, an operator will insert nozzle 24 into the filler tube of a vehicle's fuel tank to be refueled. The operator will pull up on lever 28 whereby fuel pump 14 will begin pumping fuel from dispenser tank 12, through fuel conduit 16, into fuel hose 20, and out through outlet 30, into the refueling vehicle's fuel tank.

In addition, as the operator pulls up on lever 28, vapor recovery pump 42 is engaged. Vapor recovery pump 42 draws vapor present around inlet port 31 of nozzle 24 which has been inserted into the vehicle's filler tube of a vehicle's fuel tank. The vapors present in and around a vehicle's filler tube may include fuel vapors or atmospheric air drawn into the fuel tank through filler tube under the vacuum of vapor recovery pump 42. Therefore, the recovered vapor may be fuel vapor (i.e., hydrocarbon) and/or atmospheric air.

Vapor recovery pump 42 draws the vapors through inlet port 31 into vapor recovery inlet line 22, vapor recovery conduit 44 and on to dispenser tank 12. As the recovered vapors pass by sonic transmitter 50 and sonic receiver 52, a

pulse of acoustic or sonic energy is transmitted from sonic transmitter 50 through vapor recovery conduit 44 containing the recovered vapor and received by sonic receiver 52. Controller means 58 calculates the density of vapor within vapor recovery conduit 44 convert the time it takes for a pulse of acoustic energy to traverse between sonic transmitter 50 and sonic receiver 52 to a density signal. Controller means 58 identifies the vapor constituents from the measured density. If controller means 58 identifies the vapor as being non-hydrocarbon or said alternatively, the recovered vapor containing components of air, such as oxygen, nitrogen, etc., controller means 58 sends control signal 42 to vapor recovery pump 42 to decrease the rate of operation of vapor recovery pump 42.

The lack of hydrocarbon within vapor recovery conduit 44 could indicate the vehicle being refueled is an ORVR vehicle. ORVR vehicles contain their own vapor recovery systems for removing fuel vapors from a vehicle's fuel tank. Consequently, there would be reduced fuel vapors, i.e., hydrocarbons, present in the vehicle fuel filler tube. Therefore, there would be reduced hydrocarbons present within vapor conduit 44. The lack of hydrocarbons within vapor conduit 44 is an indication that the volume of vapor recovered by vapor collection means 40 has exceeded the volume of hydrocarbon vapors present in the vehicle's fuel filler tube.

It is advantageous to decrease the rate of operation of vapor recovery pump 42.

If the lack of hydrocarbon within vapor recovery conduit 44 is an indication that the vehicle being refueled is an ORVR vehicle, it is advantageous to reduce or stop vapor recovery pump 42 from operating. Continuing to operate the vapor recovery pump in the absence of hydrocarbon vapors results in recovery of atmospheric air. As a result, a volume of recovered vapor containing no hydrocarbon will be stored in dispenser tank 12. This volume is attributed to a volume of non-hazardous or atmospheric air which was drawn into vapor collection means 40 and is added to the total volume of vapor collection. A larger volume of recovered vapor results in an increased cost of storage and disposal. Consequently, it is advantageous to only collect the volume of vapor which contains the hazardous, environmentally harmful hydrocarbons. Therefore, it is preferable to operate the vapor recovery pump 42 only when hydrocarbon is detected within vapor recovery conduit 44.

While this invention has been described as having a preferred design, the present invention can be further modified within the spirit and scope of this disclosure. This application is therefore intended to cover any variations, uses, or adaptations of the invention using its general principles. Further, this application is intended to cover

such departures from the present disclosure as come within known or customary practice in the art to which this invention pertains and which fall within the limits of the appended claims.

WHAT IS CLAIMED IS:

1. A vapor recovery system for recovering fuel tank vapor from a vehicle when the fuel tank is being refueled, comprising:

a vapor collection means for variably collecting fuel filler tube vapor from the fuel tank through a vapor recovery hose;

a density sensor means for generating a density signal representative of a density of fuel filler tube vapor;

controller means operatively connected to said vapor collection means and said density signal for controlling said vapor collection means; said controller means utilizing said density signal and generating a control signal; said control signal transmitted to said vapor collection means for varying the operational rate of said vapor collection means

2. A vapor recovery system according to Claim 1, wherein said vapor collection means comprising:

a vapor recovery pump; and

vapor recovery intake line operationally connected to said vapor recovery pump.

3. A vapor recovery system according to Claim 1, wherein said density sensor means comprises:

an acoustic transmitter; and

an acoustic receiver.

4. A vapor recovery system according to Claim 1 wherein said vapor recovery system is disposed within a fuel dispenser.

5. A method for detecting vehicles with on-board recovery vapor recovery (ORVR) systems, comprising the steps:

sampling vapor present in a fuel filler tube;

measuring the density of the sampled vapor; and

determining the presence of hydrocarbons within the sampled vapor as a function of measured vapor density;

6. The method for detecting vehicles with on-board vehicle recovery vapor recovery (ORVR) systems according to Claim 5, further comprising the step of administering fuel to a fuel tank.

7. The method for detecting vehicles with on-board vehicle recovery vapor recovery (ORVR) systems according to Claim 5 wherein the step of sampling the vapor in a fuel filler tube comprises the step of applying suction to extract vapor from adjacent the fuel filler tube.

8. The method for detecting vehicles with on-board vehicle recovery vapor recovery (ORVR) systems according to Claim 5 wherein the step of measuring the density of the sampled vapor comprises the steps:

transmitting a pulse of acoustic energy through the sampled vapor;

detecting the pulse of acoustic energy sent through the sampled vapor;

determining the density of the vapor as function of the speed by which the acoustic energy traverses the vapor.

9. The method for detecting vehicles with on-board vehicle recovery vapor recovery (ORVR) systems according to Claim 5 wherein the step of determining the composition of vapor as a function of measured vapor density, comprises the steps:

correlating the determined density of the sampled vapor to known vapor densities.

10. A method for operating a vapor recovery system comprising the steps:

supplying a vapor recovery intake line to the fuel filler tube;

applying negative pressure to said vapor recovery intake line to recover vapor;

measuring the density of the recovered vapor;

determining the composition of the recovered vapor to be one of air and hydrocarbon vapor as a function of measured vapor density;

decreasing application of negative pressure to said vapor inlet line when the determined recovered vapor composition is substantially non-hydrocarbon.

11. The method for detecting vehicles with On-Board Vehicle Recovery Vapor Recovery (ORVR) systems according to Claim 10 further comprising the step:

dispensing fuel into a fuel tank;

12. The method for detecting vehicles with On-Board Vehicle Recovery Vapor Recovery (ORVR) systems according to Claim 10 wherein the step of measuring the density of collected vapor, comprises the steps:

transmitting a pulse of acoustic energy through the recovered vapor;

detecting the pulse of acoustic energy sent through the recovered vapor; and

determining the density of the collected vapor as function of the speed by which the pulse of acoustic energy traverses the recovered vapor.

13. A vapor recovery system for recovering the vapor from a tank of a vehicle while re-fueling, comprising:

a vapor recovery intake line;

a vapor recovery pump for variably recovering vapors through said vapor recovery intake line;

a density sensor means for generating a density signal representative of a density of the vapor; said density sensor means comprising an acoustic transmitter and an acoustic receiver; and

controller means operatively connected to said vapor recovery pump and receiving said density signal; said controller means determining fuel tank vapor composition from said density signal and generating a control signal representative of said vapor composition; said control signal for varying operational rate of said vapor recovery pump as a function of said vapor composition.

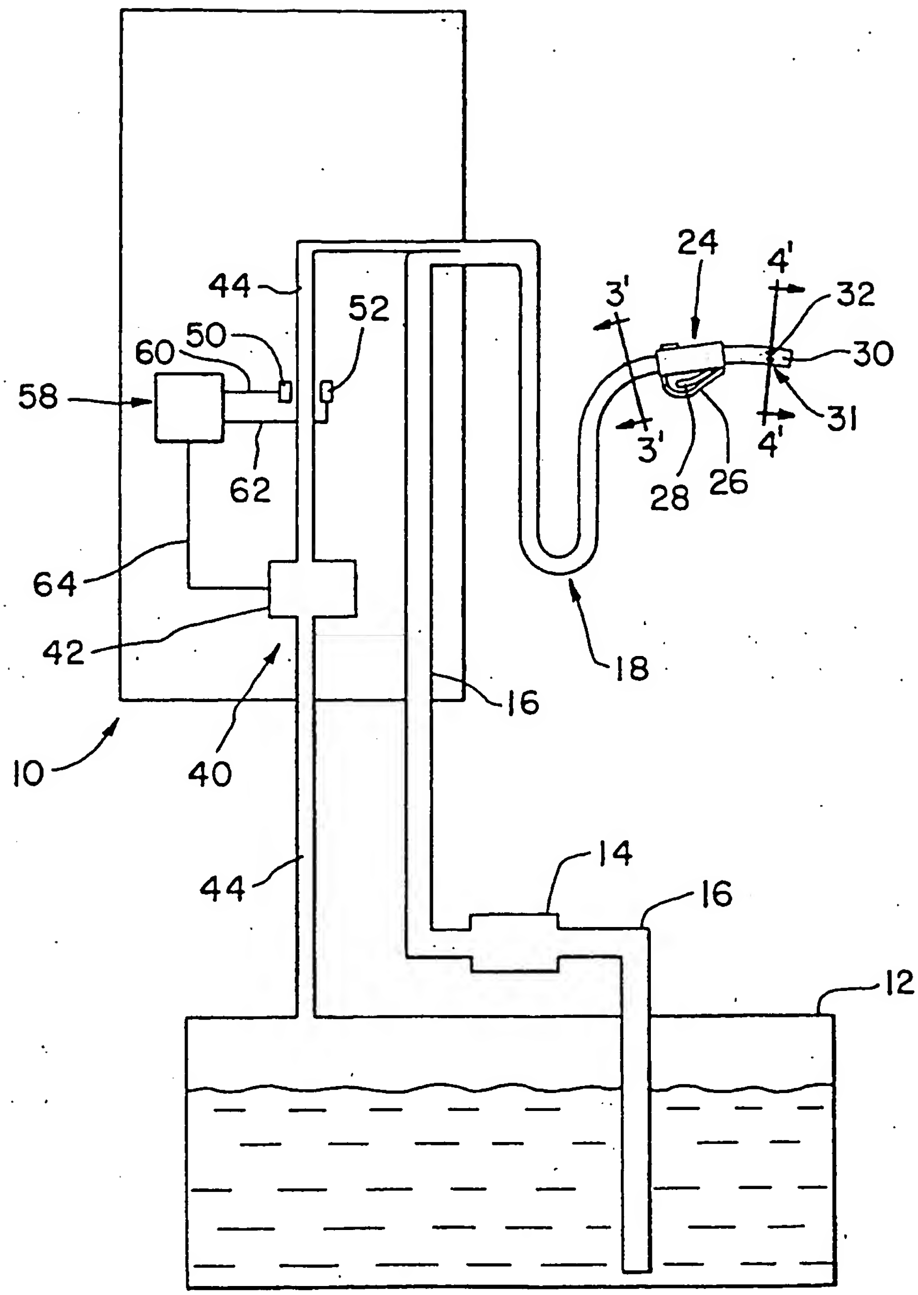

Fig. 1

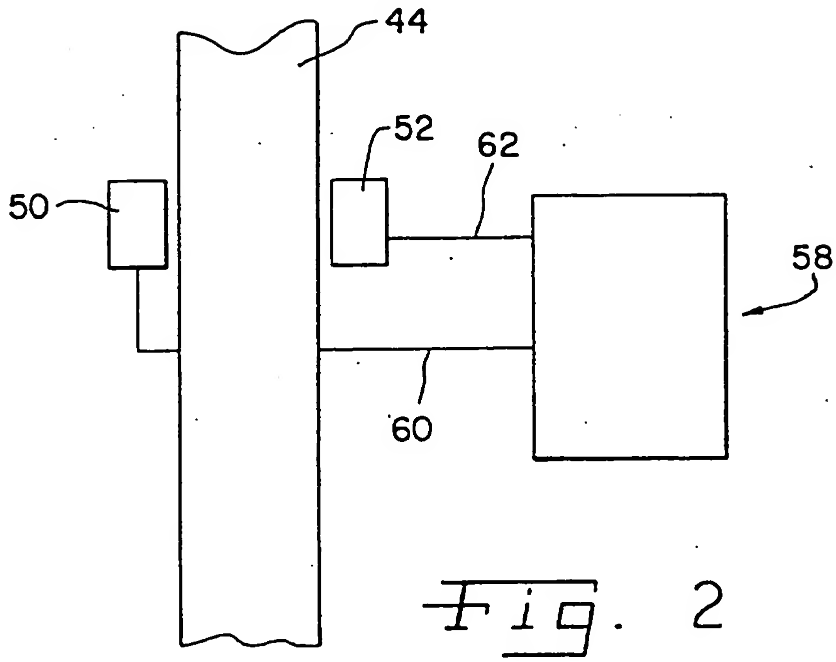

Fig. 2

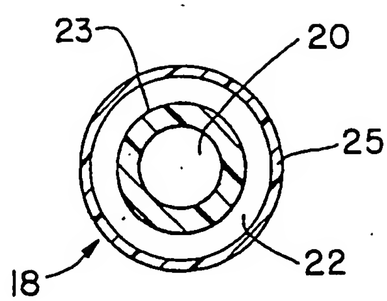

Fig. 3

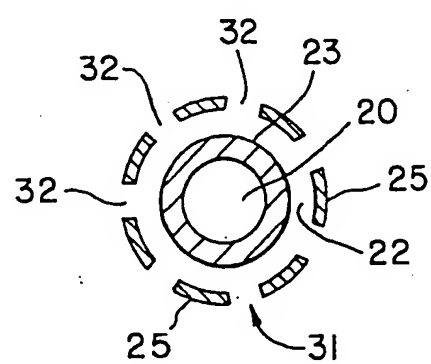

Fig. 4

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(74) Agent: RANDALL J. KNUTH, P.C.; 3510-A Stellhorn Road, Fort Wayne, IN 46815-4631 (US).

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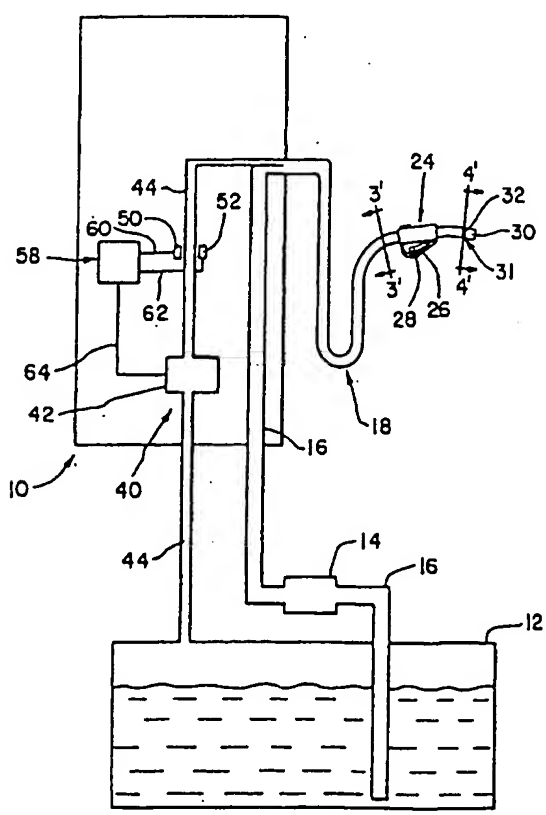

(57) Abstract: A vapor recovery system (10) with density detector (58) for identifying the vapor composition of recovered vapor. The system (10) controls the operational rate of vapor collection when the recovered vapor is identified as substantially non-hydrocarbon. Density detection is achieved through correlating the speed by which sonic or acoustic energy traverses through the recovered vapor. The vapor composition is identified by comparing measured density of the vapor collected to known vapor densities.

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INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER

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According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 141/59,206-229, 83, 98, 198, 302, 307, 308, 392, DIG. 1; 73/861.28

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Please See Continuation Sheet

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,913,343 A (ANDERSON) 22 June 1999 (22.06.1999), column 7, lines 26-36; column 6, lines 51-58.	1-4, 10 and 13
Y	US 5,782,275 A (HARTSELL, JR. ET AL) 21 July 1998 (21.07.1998), column 2, lines 46-47.	1-13

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

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Date of the actual completion of the international search	Date of mailing of the international search report
04 AUGUST 2000 (04.08.2000)	22 AUG 2000

Name and mailing address of the ISA/US	Authorized officer
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Form PCT/ISA/210 (second sheet) (July 1998)

INTERNATIONAL SEARCH REPORT	International application No. PCT/US00/03695

Continuation of B. FIELDS SEARCHED Item 3: EAST text search
Search terms: density and sensor, vapor recovery system, ORVR, acoustic sensor, density sensor, fuel filling